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Males and Intersexes in a Normally Thelyotokous Insect, *Tropidophryne melvillei* Compere (Hymenoptera, Encyrtidae)

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Tropidophryne melvillei Compere is apparently indigenous to the region of Kenya Colony, Africa, where it was found to parasitize *Pseudococcus* sp. (Compere, 1939). In 1948 this parasite was introduced into California from Kenya Colony by the Division of Biological Control of the University of California Agricultural Experiment Station (Smith and Flanders, 1949).

Biological observations indicate that in California *T. melvillei* will develop in *Pseudococcus citri* (Risso) and *P. adonidum* (Linnaeus). No reproduction was obtained when this parasite was tested on *P. gahani* Green, *P. maritimus* (Ehrhorn), and *Phenacoccus gossypii* (Townsend and Cockerell). The egg of *T. melvillei* is of the stalked type, deposited internally and singly in the host, and without respiratory function. The first instar larvae are caudate while the mature larvae are typically hymenopteriform. Pupation occurs within the mummified carcass of the mealybug, and the usual manner of adult emergence is through a circular hole cut in the dorsum of the host. The parasite is solitary, and tests have shown that unisexual (thelyotokous) reproduction is normal. For example, twenty pupae were selected at random, and each was isolated from other *Tropidophryne*. Upon emergence each specimen was found to be female, and these isolated parasites yielded only female progeny.

Although laboratory cultures of *T. melvillei* seem to produce only females generation after generation, a few males do occasionally appear. Furthermore, careful analysis of these specimens has disclosed the occurrence of intersexes. In one cage the progeny from 471 females totalled 11,487 individuals among which were found 63 males and 3 intersexes. Another population with a remarkably high frequency of occurrence of intersexes was composed of 397 females, 13 males, and 9 intersexes.

The males exhibit the characteristic behaviour of most encyrtids of that sex, and viable spermatozoa were found in their testes. Dissection of a female after copulation showed her spermatheca to contain spermatozoa. The progeny obtained from mated females were all female and these individuals, perhaps biparental, were indistinguishable from the normal uniparental progeny of virgin females. The male sex in *T. melvillei* is probably an atavism, for it apparently no longer fulfills a requisite function in the perpetuation of the species. Since no males of *T. melvillei* have been recorded in taxonomic literature, the following description may be of value.

Tropidophryne melvillei Compere

Male.—Head, dorsal view, almost 3 times wider than long (14.5:5); frontovertex slightly wider than long (6:5), occupying slightly less than one-half the width of the head (6: 15). Frontovertex not widely expanded anteriorly as in female, narrowest between eyes just anterior to posterior ocelli. Ocelli not forming equilateral triangle, posterior pair separated by distance greater than that between themselves and anterior ocellus. Head, frontal view, only slightly wider than high. Face not deeply excavated, protruding prominently between antennae. Scrobes not differentiated from face.

Antennae inserted slightly below middle of face, upper portion of antennal sockets just meeting an imaginary line drawn between the lower margins of eyes. Antenna, fig. 1F, composed of scape, pedicel, six funicle segments, and solid club. Scape somewhat flattened, very slightly expanded ventrally. Each funicle segment tends to be slightly larger than one preceding, each segment slightly wider at apex than at base. Club solid, cylindrical at base and of width approximating that of preceding funicle segment, but tapering toward rounded apex; club equal in length to last 3 funicle segments combined.

Mandibles bidentate. Maxillary palpi 4 jointed, labial palpi 3 jointed.

Pronotum short. Mesoscutum one and one-half times as wide as long. Axillae connate. Scutellum subequal to mesoscutum in length.

Wings hyaline. Costal margin without appreciable notch at termination of submarginal vein as is found in female wing. Stigmal vein straight, slightly enlarged at apex, much longer than postmarginal. Wings in repose extend beyond body for distance equal to total abdominal length.

General body color black, with blue and purple reflected highlights. Legs blackish except first four tarsal segments which are pallid, metatarsal segment dusky.

Average body length 1.0 mm.

Described from 20 males taken from insectary cultures, Albany, California, May 15, 1950. R. L. Doutt. Host, *Pseudococcus citri* (Risso). *Type* and *paratypes* in the collection of the Division of Biological Control, University of California. A series of *paratypes* to be deposited in the U.S. National Museum.

The hyaline wings of *T. melvillei* males may serve to distinguish this species from the males of *T. palestinensis* Rivnay (1945) which are reported to have infuscated wings.

The males may be readily distinguished from the females of *T. melvillei* by morphological differences other than those of genitalia. The most striking dissimilarity is exhibited by the structure of the antennae and head, fig. 1A, F. The male wing differs by being hyaline, and by having a straight stigmal vein with an apical expansion, whereas in the female the wing is infuscated, the stigmal vein is curved and lacks the apical expansion. The male pronotum is relatively much shorter than that of the female. The black coloring of the legs and sternum of the male differs from the brown hue of these structures in the female.

Intersexes.—Among the population of males reared in the laboratory cultures were a number of specimens showing abnormalities in antennal and head structures. These structures deviated from the normal by being feminized, i.e., they showed characteristics which to some degree approached femaleness. The range in variation was from an individual showing a very slight modification of one scape to an individual with the entire head and both antennae distinctly feminized, although not distinctly female. It is significant that all of these intergradations exist, but that in no case was a distinctly female structure found to coexist with male parts in any single individual. The various degrees of feminization of male structures seem to indicate that such abnormal specimens should be termed intersexes, rather than gynandromorphs.[1]

In *T. melvillei* intersexuality is most easily seen in the antennal structures. It may be expressed as merely an abnormal expansion of the ventral part of one scape, or it may be seen only as a partial fusion of two funicle segments. This tendency of the funicle segments to unite is shown in the photomicrograph,

[1]The authors are grateful to Professor Richard Goldschmidt for his determination of these abnormal specimens as intersexes, and to Professor P. W. Whiting for his suggestions and review of the manuscript.

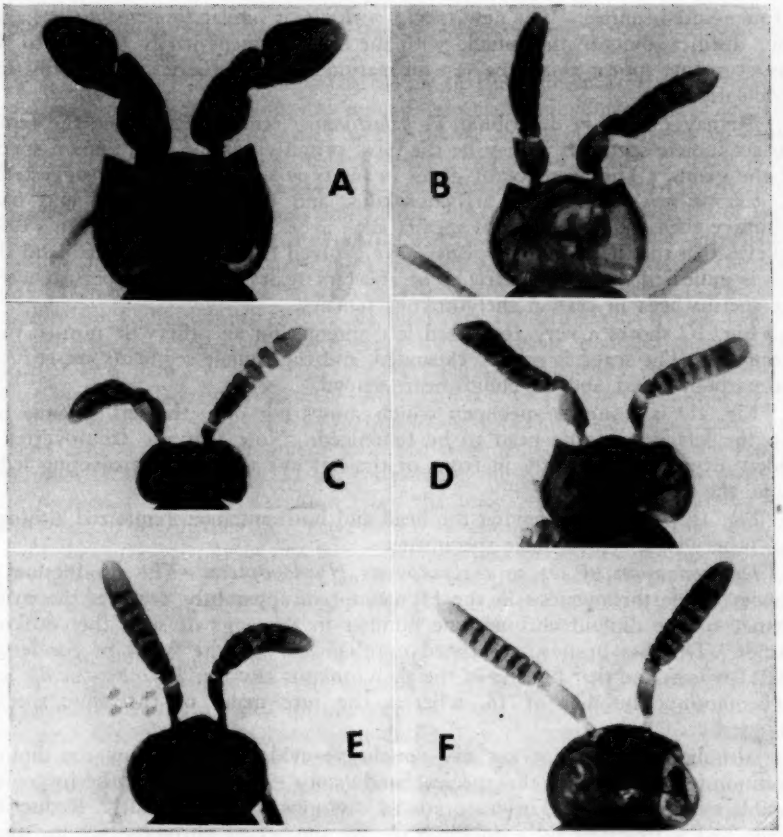

FIG. 1. Photomicrographs of head and antennal structures of *Tropidophryne melvillei* Compere. A. Typical female. B, C, D, E, Intersexes. F. Typical male.

fig. 1E. This specimen has a normal male antenna on the left, but the right antenna shows five funicle segments in the process of fusion.

This fusion of funicle segments, with the attendant loss of articulations, reduces the normal male complement of six funicle segments to fewer in feminized antennae. In this regard it is interesting to note the tendency for such a fusion to occur in normal female antennae. Compere (1939) concluded that in the species of *Tropidophryne* the funicle joints[2] of the female antennae seem to be in the process of reduction, and he was forced to amend the original generic description to provide for a variable number of funicle segments. He altered the original description of five funicle joints in the genotypic species *T. africanus* Compere with the following comment: "It would have been more accurate to have stated, funicle with four distinct joints and a fifth segment at base not individually articulated nor separately cut off dorsally. The new species, *natalensis*, has three distinct funicle joints. The basal joint is divided below the point of articulation, the divided ventral expansion producing the appearance of

[2]Some authors tend to use the word "joint" in the sense of meaning segment. It does not refer to an articulation.

a four jointed funicle. The new species *melvillei* is similar to *africanus* in having four distinct joints in the funicle with the basal segment partly divided so that five segments appear along the ventral margin although there may be only four articulations."

Rivnay (1945) in describing *T. palestinensis* remarks that since the female has six funicle segments it may be the most primitive of the four known species of the genus. The presence of males in his type series might also suggest that *T. palestinensis* is normally arrhenotokous, and therefore bisexual and more primitive than the thelyotokous species such as *T. melvillei*. Sanderson (1932) believes that the thelyotokous species have evolved from bisexual species and that this is indicated by the occurrence of aberrant males and by the persistence of the spermatheca in certain thelyotokous females.

Fig. 1C shows a very feminized left antenna on an otherwise normal male specimen. The scape is greatly expanded, and the funicle segments are reduced and partially fused, and the club is heart-shaped.

Fig. 1D is a similar specimen which shows not only the left antenna but also the left side of the head to be feminized. Note that the frontovertex is widely expanded anteriorly in front of the left eye to form a projecting ledge above the face.

Fig. 1B is unique in having the head and both antennae feminized although it is otherwise a typical male specimen.

Determination of sex in thelyotokous Hymenoptera.—The production of females by parthenogenesis in the Hymenoptera apparently requires the maintenance of the diploid chromosome number in the eggs of such thelyotokous species. This has been substantiated cytologically by the work of Sanderson (1932) who found that females of the thelyotokous saw-fly, *Thrinax macula*, had a chromosome number of 16, whereas the rare males of the same species possessed 8.

Although there is not yet any conclusive evidence as to how the diploid condition is maintained in this species, Sanderson (1932) suggested the following possible explanations: 1. The maturational divisions are equational; 2. Reduction occurs and is followed by a doubling of the number of chromosomes by some means; *a*, either by the fusion of a polar body with the egg nucleus as in Echinoderms, or, *b*, by a regenerative doubling of number in segmentation nuclei, as in *Rhodites*.

Speicher (1937) has called attention to still other mechanisms employed by thelyotokous Hymenoptera to retain the diploid number of chromosomes in the offspring: (1) Doncaster, and later Dodds, found that in the spring generation of *Neuroteres lenticularis* a complete suppression of both maturation divisions occurs, so that the primary oocyte nucleus passes directly into cleavage. (2) Silvestri reported a single maturation division to occur in the female-producing eggs of *Prospaltella*. (3) Speicher found that in *Nemeritis canescens* the first maturation division was somewhat "abortive" in that no polar nucleus was formed, but the egg nucleus before the division possessed a haploid number of tetrads and afterwards a diploid number of dyads. The second maturation division resulted in the formation of a single polar nucleus and the ootid nucleus. Apparently the eleven dyads forming each nucleus fall apart to give twenty-two chromosomes.

Speicher explained the absence of males in *Nemeritis* on the basis of the peculiar susceptibility of haploid males to recessive lethal mutations. These recessive mutations would have no great effect on the majority of diploid offspring which would be "protected" by a dominant allel. Speicher feels that

as soon as a haploid egg was formed these lethal genes would be uncovered and the offspring would be non-viable.

Flanders (1944) has expressed the theory that in thelyotokous Hymenoptera the ovarian tissue is tetraploid and reduces to form diploid eggs. He explains the occasional appearance of males on the theory that diploid patches of tissue, which reduce to form haploid (male-producing) eggs, are present in the ovaries.

Since no cytological evidence is as yet available in regard to the origin of intersexes in thelyotokous species any theory concerning the mechanism of their origin is pure speculation. It is probable that they arise from some disturbance in genic balance, as this has been the basic area of agreement between the outstanding workers who have studied intersexuality among insects (*Lymantria* intersexes by Goldschmidt, *Drosophila* intersexes by Bridges). In the case of *Lymantria* the balance which determines sex apparently operates through the action of two genes which may vary in strength or valency; in the case of *Drosophila* this balance may be reached through the interaction of multiple genes.

In the case of *Tropidophryne* the intersexes apparently started as males, but at some time during development switched over and developed in the female direction. Goldschmidt (1923) has shown that the earlier this shift occurs the more marked will be the deviation from the basic, genetically-determined sex. It also seems to be true that the greater the excess of one type of gene over another or the greater the valency of one factor over another the earlier will the development be altered. There is some evidence that these factors may be further influenced by the physical, external environment of the organism (Dobzhansky, 1930).

It is of interest to note that Whiting, Greb, and Speicher (1934) found weakly intersexual males in *Habrobracon hebetor* (Say), an arrhenotokous species. They found that these males, termed gynoid, were caused by a simple recessive gene, *gy*. Gynoid females have been derived by mating heterozygous females to gynoid males. Since these females, as virgins, produce gynoid males only, a gynoid stock has been derived which breeds true and indicates that the heredity of this factor for weak intersexuality is in every way similar to that of other recessives.

It is reasonable speculation, as Whiting[3] has suggested, that in a thelyotokous species genic changes occur which are subliminal due to the diploid nature of the females. The haploids appearing after resumption of completion of meiosis may then include, in addition to normal males, males of various degrees of intersexuality.

Summary

Males and intersexes occasionally appear in laboratory cultures of the normally unisexual (thelyotokous) African encyrtid, *Tropidophryne melvillei* Compere, an internal parasite of the citrus mealybug and long-tailed mealybug in California. The male of *T. melvillei* is described for the first time. The abnormal individuals which are basically male, but show varying degrees of femaleness, are termed intersexes and are discussed in detail with theories as to their possible origin.

[3]In correspondence to the senior author, dated August 2, 1950.

References

Compere, Harold. 1939. A second report on some miscellaneous African Encyrtidae in the British Museum. *Bull. Ent. Res. 30* (1): 1-26.

Dobzhansky, T. 1930. Genetical and environmental factors influencing the types of intersexes in *Drosophila melanogaster*. *Amer. Nat. 64*: 261-271.

Flanders, S. E. 1944. Uniparentalism in the Hymenoptera and its relation to polyploidy. *Science 100* (2591): 168-169.

Goldschmidt, Richard. 1923. The mechanism and physiology of sex determination. (English translation by W. J. Dakin). Methuen & Co. Ltd., London. 259 pp.
Rivnay, E. 1945. Notes on Encyrtidae from Palestine with the description of a new species. *Jour. Ent. Soc. South Africa 8*: 117-122.
Sanderson, Ann R. 1932. The cytology of parthenogenesis in Tenthredinidae. *Genetica 14*: 321-451.
Smith, H. S. and S. E. Flanders. 1949. Recent introductions of entomophagous insects into California. *Jour. Econ. Ent. 42* (6): 995-996.
Speicher, B. R. 1937. Oogenesis in a thelytokous wasp, *Nemeritis canescens* (Grav.). *Jour. Morph. 61*: 453-472.
Whiting, P. W., R. J. Greb, and B. R. Speicher. 1934. A new type of sex intergrade. *Biol. Bull. 66*: 152-165.

The Effect of the Miticide Neotran* Upon the Laboratory Production of *Aspidiotus lataniae* Signoret as a Coccinellid Food

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The large scale production of Coccinellids at the Fontana Laboratory, Commonwealth Bureau of Biological Control, Fontana, California, for shipment to Bermuda where they are used against the Diaspine Cedar Scale, *Carulaspis visci* Schrank has created a variety of problems. Potato tubers are being used to rear the Diaspine scales *Aonidiella aurantii* Mask., *Aspidiotus lataniae* Signoret, and *Aspidiotus hederae* Vallot for host material for the Coccinellids *Zagloba ornata* Casey, *Cephaloscymnus occidentalis* Horn, *Microweisea suturalis* Schwartz, *Lotis nigerrima* Casey, *Lotis neglecta* Muls., *Pharoscymnus exiguus* Weise, *Telsimia* sp., and the Nitidulid *Cybocephalus* sp. One of the outstanding difficulties was the damage caused by several species of predaceous mites as contaminants in our production program. The elimination of these mites led to the rather novel use of miticides as a means of sanitation control. The results although effective were open to experimental error. This preliminary report deals primarily with the effectiveness of Neotran on these mites, *Hemisarcoptes malus* Schimer, *Iphidulus* sp., *Tyroglyphus americanus* Banks, the associated effect upon the production of the Diaspine scale *Aspidiotus lataniae*, and the subsequent effect on the production of the Coccinellids.

The presence of these mites on our host material, potato tubers laboratory infested with the scale *Aspidiotus lataniae*, was first called to our attention by the premature cessation of crawler production. Careful examination of the mature scale revealed a heavy infestation of *Hemisarcoptes malus*, secondary infestations of *Seiulus* sp. now thought to be *Iphidulus* sp., and *Tyroglyphus americanus*.

It was found that the mites, *Hemisarcoptes malus* and *Iphidulus* sp.,[1] appear on relatively young scale, i.e., two weeks after infestations with scale crawlers. The mite population remains relatively light until the chitinous shell of the scale is lifted to permit crawlers to emerge. This change increases the accessibility of the food supply to the mite and provides an excellent place for oviposition. Under these optimum conditions *H. malus* is by far the predominant mite. *Iphidulus* was encountered only occasionally. The sugar mite, *Tyroglyphus americanus*, does not appear in numbers until the onset of decomposition of the potato tuber. *Aspidiotus lataniae* seems to afford *H. malus* with an ideal environment for reproduction. The mites which usually feed upon the scale crawlers have been observed attacking the mature scale. The migratory form

*K1875 Dow Chemical Co.
[1]*H. malus* and *Iphidulus* sp. were present in the original insectary produced stocks obtained for this project.

of *H. malus* has been observed attacking the puparia of the Coccinellid *Zagloba ornata.*

The program originally included plans to test the efficacy of three general miticides. Two of these, Neotran and K6451, are products of the Dow Chemical Co. The active compound in Neotran is Bis(p-chlorophenoxy)methane. The chemical composition of K6451 has not yet been released since it is still in the experimental stage. Neotran is sold in a 40% wettable mixture, and K6451 may be obtained in a 50% wettable mixture. The third miticide, Dimite (D.M.C.), is a product of the Sherwin-Williams Co. Its chemical composition is 2(p-chlorophenyl)ethyl carbinol, and it is available in a 25% emulsifiable solution.

Preliminary tests utilizing the above miticides on mature *Aspidiotus lataniae* proved K6451 and D.M.C. to be too toxic to mature scale and crawlers as well as to the mites to be practicable for sanitation purposes. A series of control experiments are planned using these miticides in weaker concentrations.

The preliminary trials were carried out using the following solution strengths.

K1875 (Neotran)	40% wettable	1.701 g/qt H_2O
K6451	50% wettable	1.701 g/qt H_2O
D.M.C. (Dimite)	25% Emulsifiable	1.183 ml/qt H_2O

I. *The effect of Neotran upon mother stock (Aspidiotus lataniae) during the period of high crawler production.*

A. Using host material free of mites.

B. Using host material infested with *Hemisarcoptes malus* and *Iphidulus* sp.

Mother stock of *Aspidiotus lataniae*, which was free of mites, and mother stock which had become infested with *Hemisarcoptes malus* and *Iphidulus* sp. were sprayed with a Neotran solution. Both samples were chosen so as to insure that the mature scale was in full crawler production. The extent of the infestation was determined by a count of the number of mites within a one-half inch square on a representative sample. These samples were sprayed until the excess solution dripped from the tubers.

This procedure demonstrated conclusively that Neotran has a residual effect, as well as a direct effect, which is very efficient in the control of a heavy mite infestation. Two days after spraying, a recount of the mite population was taken from an equally representative sample. The mite population had decreased from the original sixty to the one-half inch square to thirteen to the one-half inch square, or approximately one-fourth. Four days after the original treatment, the count decreased to six to the one-half inch square. On the sixth day, the mite population had dropped to slightly over one to the one-half inch square, or approximately one sixtieth of the original infestation.

Close examination of the mature *Aspidiotus lataniae* indicated that the miticide Neotran is lethal to a certain extent. Apparently only those scale which have settled on the covers of other scale so as to form a second layer are harmed.

II. *The effect of Neotran on scale crawlers.*

Neotran is lethal to the scale crawlers. During the progress of this series of tests, it was found that Neotran has a retarding effect upon crawler production. Crawler production by *Aspidiotus lataniae* was retarded for an average of two weeks regardless of the stage of development at the time of treatment. Mature *A. lataniae*, which was producing crawlers, was sprayed, and crawler production was inhibited for approximately two weeks. Crawlers began to appear as early as the seventh day, but the normal number of crawlers was not reached until the fourteenth or fifteenth day. Young *A. lataniae* sprayed at the end of the seventh day after the formation of the chitinous shell suffered no apparent after effects other than to retard crawler production by approximately two weeks.

III. *The effect of Neotran upon host material during the period preceding the lifting of the chitinous shell to allow the crawlers to emerge.*

Mite control measures using Neotran are more efficient when instituted after the formation of the chitinous shell and before the marginal edge of the shell is freed from the tuber epidermis to permit the crawlers to leave.

A preliminary examination of the residual effectiveness of Neotran in mite control during this stage of development was started using *Aspidiotus lataniae* which had been settled seven days. A count of the mites from a representative sample averaged sixteen to the one-half inch square. These tubers were sprayed until the excess dripped. A count taken two days later yielded an average of less than one to the one-half inch square, and two days later only one adult *Hemisarcoptes malus* could be found on the total surface of ten potato tubers.

At the time this test was carried out, the migratory form of *Hemisarcoptes malus* was observed to be on both the control and the treated trays of *Aspidiotus lataniae*. When a check was made two days later, the migratory form had disappeared from both the control and the treated stock. Therefore, no conclusion could be reached regarding the effectiveness of Neotran against this migratory form of *H. malus*.

IV. *The residual effect of Neotran upon clean, recently fumigated potato tubers with respect to the effect upon infestation with scale crawlers of* ASPIDIOTUS LATANIAE.

Clean, fumigated potato tubers were heavily sprayed with Neotran, marked, and placed in trays with untreated potatoes to be infested with *Aspidiotus lataniae* crawlers. This experiment indicated that this would be the ideal time to control mite infestations since there was little variation in the behavior of the scale infestation between the treated and the untreated potatoes. The slight decrease in the extent of the scale infestation was attributed to the residual effect of Neotran.

When this procedure was put into general practice in order to control a general mite infestation, it was found that approximately half of the scale crawlers were not settling properly and formed a fine, wax-like web instead of the expected cover. Both typical and atypical forms were present on the same tuber.

Since there were two possibilities of contamination, this procedure will be repeated under other conditions. In order to eliminate any possibility of contamination due to the inert material in the Néotran mixture, the Bis(p-chlorophenoxy)methane will be purified and used in the pure state.

The second possibility arises from the fact that the spraying equipment was used with DDT (dichloro-diphenyl-trichloroethane) in other sanitary measures. This possibility has been eliminated by the purchase of a new spray gun.

V. *The effect of Neotran on the larval stage of a predator, (Zagloba ornata).*

In order to determine the effects of Neotran on the larval stage, thirty larvae of *Zagloba ornata* were placed on treated host material. No harmful effects were noted and the puparia were transferred to another problem. As soon as the pure compound bis(p-chlorophenoxy)methane is available, this series will be repeated and continued throughout a full generation.

VI. *The effect of miticide upon predators when subjugated to a direct spray of Neotran.*

Fifty *Zagloba ornata* were placed on untreated host material and were then sprayed with Neotran. Except for two beetles which drowned in pools of Neotran, no harmful effects were noted.

VII. *The effect of Neotran upon predators which were fed with treated host material.*

Fifty *Zagloba ornata* were placed on host material, *Aspidiotus lataniae,* which had been treated with Neotran, and under experimental conditions no harmful effects were noted. Widespread use of this procedure, however, resulted in a marked drop in beetle production. These results again are inconclusive because of the possibilities of contamination and will be repeated under more carefully controlled conditions.

A New Species of *Laccocera* from Canada and Records of Other Canadian Species (Homoptera: Araeopidae)[1]

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The fulgorids of the genus *Laccocera* Van Duzee were revised by Penner (1945. J. Kansas Ent. Soc. 18: 30-46), who described and figured the seven species known to occur in North America. In all, five species are represented in the Canadian National Collection. One of these is previously undescribed, and three others have not been recorded from Canada previously. The following are a description of the new species and records of other Canadian species from specimens in the Collection.

***Laccocera canadensis* n. sp.**

Length of macropterous male: to tip of abdomen, 2.6 mm., to tip of forewing, 3.4 mm.; length of macropterous female: to tip of abdomen, 2.8 mm., to tip of forewing, 3.8 mm.

Vertex (Fig. 1) as long as wide; anterior margin rounded, posterior margin straight; median cell angulate anteriorly; lateral cells large, each with two well-defined pits; basal cells large, with the carinae distinct. Frons (Fig. 2) longer than wide, widest above the middle; each half with seven pits, of which three are near the margin next the eyes and four are in a straight line parallel to the median carina. Pronotum two-thirds as long as the vertex, three times as wide as its median length; with nine pits on each side. Scutellum about twice as wide as long.

Vertex dirty yellow; face dirty yellow, slightly darker than the vertex and becoming brownish in the lateral compartments of the clypeus; head sometimes brownish at the sides below the eyes. Prothorax dirty yellow; scutellum dirty yellow to yellowish-brown, with a brownish-red suffusion in each lateral compartment. Legs light brown, with the coxae and the pleural pieces brown. Wings smoky hyaline, the veins brown. Abdomen dark brown, with the pits and the posterior margins of the segments yellowish.

Male genitalia: styles (Fig. 3) each broad basally, tapering and sinuately curving, and ending in a slight hook; aedoeagus (Fig. 4) broad at proximal end, narrowed through middle, and expanded at apex, curved upward beyond the base and downward near the apex, the apical portion margined below with a row of teeth and with a band of teeth on each side extending down the shaft to the first bend, the tip being sharply pointed; processes of anal appendage short, curved, and rapidly tapering (Fig. 5).

Described from eight macropterous specimens. This species is easily recognized by characters of the male genitalia, notably the form and ornamentation of the aedoeagus.

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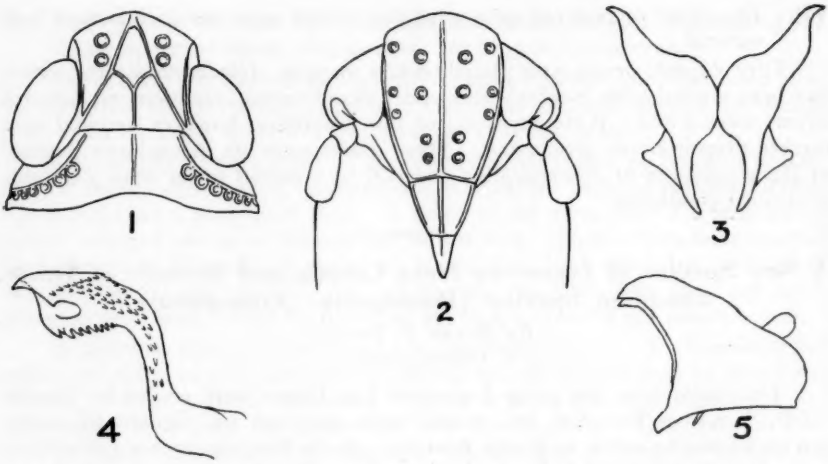

FIGS. 1-5. *Laccocera canadensis* n. sp. 1, vertex and prothorax; 2, face; 3, male styles, ventral view; 4, aedeagus, lateral view; 5, anal appendage of male, lateral view.

Holotype ♂:—Saskatoon, Saskatchewan, May 17, 1925 (K. M. King). No. 5904 in the Canadian National Collection, Ottawa.

Allotype ♀:—Same data as holotype.

Paratypes:—2 ♂, Saskatoon, Saskatchewan, May 15, 1923 (K. M. King); 2 ♀, same data as holotype; 2 ♀, same data as male paratypes.

***Laccocera vittipennis* (Van Duzee)**

This is the only member of the genus that has been recorded previously from Canada. It appears to be common and widely distributed. Quebec: Kazubazua, Covey Hill, and Knowlton (G. S. Walley); Ontario: Bell's Corners (E. G. Lester), Norway Point, Lake of Bays (J. McDunnough), Fisher Glen and Ottawa (G. S. Walley); Saskatchewan: Saskatoon (K. M. King, N. J. Atkinson, and A. R. Brooks), Rutland and Attons Lake, Cut Knife (A. R. Brooks), Roadene and Fish Creek (K. M. King), Pike Lake (B. P. Beirne); Alberta: Lethbridge (R. W. Salt, J. H. Pepper, and B. P. Beirne), Raymond (E. H. Strickland), Glenwood (R. W. Salt), Medicine Hat (J. H. Pepper); British Columbia: Rolla (P. N. Vroom).

***Laccocera obesa* (Van Duzee)**

Saskatchewan: Saskatoon (K. M. King).

***Laccocera flava* Crawford**

Alberta: Lethbridge and Medicine Hat (J. H. Pepper).

***Laccocera oregonensis* Penner**

British Columbia: Kamloops and Summerland (B. P. Beirne).

Studies on the Resistance of Plants to Aphids by the Method of Paper Partition Chromatography[1]

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The factors responsible for the relative resistance of plants to aphid attack are not very well known. Chemical analyses of several varieties of peas indicate that the quantity of nitrogenous constituents in plant juice is proportional to the susceptibility of the plant to aphid attack. These tests have also demonstrated that amino acids represent the major portion of the soluble nitrogenous constituents in the plants studied.

By the method of paper partition chromatography, several qualitative and semi-quantitative analyses were made of the amino acids in juice extracts of two varieties of peas and of pea aphids feeding on these varieties. This particular method of chromatography, first developed in England in 1944 by Consden, Gordon, and Martin (1), and modified since by other workers (2, 3), was found very effective for these studies.

The technique developed for the extraction of the plant juice and its preparation for chromatographic analysis was as follows: Plant juice was extracted from samples of plants of peas that had been stripped of their leaves. The samples were crushed in a porcelain Gooch crucible with a suitable glass rod. The Gooch crucible was placed on a filtering flask connected to a vacuum pump, and a light suction was applied while the plants were being crushed. The extract was collected in a vial placed in the flask. The vial containing the juice was immersed for three minutes in a bath of boiling water. This treatment resulted in the coagulation and the precipitation of the albumins that carried with them the chlorophylls and possibly a few other proteins. The resulting clear yellowish liquid was separated from the precipitate by centrifugation and made aseptic with 0.2 gm. of phenol in 100 ml. For the chromatographic analysis, 1 ml. of the liquid was evaporated to dryness under vacuum at room temperature. The residue was subsequently treated three times with 5-ml. portions of 80 per cent ethanol for the extraction of amino acids. The extracts were added together, centrifuged, and evaporated to dryness at a temperature of 40°C. and under a continuous jet of air. The dry residue was redissolved in 100 microliters of water, and from 15- to 30- microliter aliquots were chromatographed in two dimensions. The same method of preparation was used for the analysis of free amino acids in whole aphids. The results of these analyses are given in Table I.

The results of chromatographic analyses (Table I) show the presence of 11 free amino acids in the plant juice extracts and 15 in the pea aphid extracts. Amino acids with higher molecular weights, such as tryptophane, tyrosine, and arginine, were absent, or present only in traces, in the plants analyzed, but they were found in aphids feeding on these plants. Quantitative differences in the amino acids were observed in the two varieties of peas. The susceptible variety Perfection gave in general denser chromatograms than the resistant variety Champion of England, showing that the susceptible variety contained a higher concentration of amino acids than the resistant one. On the other hand, the amino acid proline was present in higher concentration in the resistant variety. It is very likely that these differences constitute important factors of resistance or susceptibility to the pea aphid.

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TABLE I.

OCCURRENCE OF FREE AMINO ACIDS IN PLANT SAMPLES OF TWO VARIETIES OF PEAS AND IN APHIDS COLLECTED FROM THESE VARIETIES.

Amino compound	Plant juice extract		Extract from the pea aphids collected on:	
	Champion of England (resistant)	Perfection (susceptible)	Champion of England (resistant)	Perfection (susceptible)
Aspartic acid	x	x	x	x
Glutamic acid	x	x	x	x
Serine	x	x	x	x
Asparagine	x	x	x	x
Threonine	x	x	x	x
Alanine	x	x	x	x
Glutamine	x	x	x	x
Methionine	x	x	x	x
Proline	x	x	x	x
Valine	x	x	x	x
Leucine and/or isoleucine	x	x	x	x
Beta-alanine			?	x
Tyrosine			x	x
Arginine			x	x
Glycine			x	x

Summary

By the use of paper partition chromatography, qualitative and semi-quantitative analyses were made of free amino acids in plant juice extracts of two varieties of peas and in aphids collected on these varieties. Amino acids in plants and in aphids were extracted with 80 per cent ethanol by a special technique developed for paper partition chromatography. The results of the analyses show the presence of 11 amino acids in the plant juice extracts and 15 in the pea aphid extracts. The variety susceptible to pea aphid attacks contains a higher concentration of amino acids than the resistant variety, with the exception of the amino acid proline.

References

1. Consden, R., A. H. Gordon and A. J. R. Martin. Qualitative analysis of proteins: a partition chromatographic method using paper. *Biochem. J. 38:* 224-32. 1944.
2. Pratt, J. J., Jr. and J. L. Auclair. The sensitivity of the ninhydrin reaction in paper partition chromatography. *Science 108:* 213. 1948.
3. Williams, R. J. and H. Kirby. Paper chromatography using capillary ascent. *Science 107:* 481. 1948.

A Bibliography of Honey Bee Toxicology[1]

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Introduction

Interest in honey bee toxicology has recently received a fresh impetus as a result of the development of many new insecticides and the more general appreciation of the honey bee as an important pollinator. In particular, for seed setting in many legumes the honey bee appears to be essential. This bibliography is therefore presented at this time to serve as a guide to the literature. The extent of the literature is considerable: the bibliography is extensive, but it would be unwise to claim that it is complete. It contains references up to the fall of 1949.

The Review of Applied Entomology (R.A.E.) has proved useful in the compilation.

Bertholf, L. M. and Pilson, J. E. 1941. Studies on toxicity to honey bees of acid lead arsenate, calcium arsenate, phenothiazine and cryolite. *J. Econ. Ent. 34:* 24-33.

Beard, R. L. 1949. Species-specificity of toxicants as related to route of administration. *J. Econ. Ent. 42:* 292-300.

Bishop, P. 1923. Dry dusting poisons bees. *Gleanings Bee Cult. 51:* 250.

Böttcher, F. K. 1937. Bienensturben durch Schädlingsbekämpfung. *Angew. Chem. 50:* 81-84. *R.A.E.(A) 25:* 211.

Böttcher, F. K. 1937. Die wirkung der chemischen Schädlingsbekämpfung auf die Bienenzucht. Ein Rückblick auf vergiftungsfälle, wissenschaftliche Untersuchungen und deren Methodik. *Anz. Schädlingsk 13:* 105-114; 121-126. *R.A.E. 25:* 802.

Bourne, A. I. 1927. The poisoning of honey bees by orchard sprays. *Bull. Mass. Agr. Expt. Stat. No. 234,* pp. 74-84.

Brittain, W. H. 1933. Apple pollination studies in the Annapolis Valley, N.S., Canada, 1923-32. *Bull. Dept. Agr. Canada No. 162.*

Butler, C. G. 1943. Symposium on the honey bee. Work on repellents. Management of colonies for pollination. *Ann. Appl. Biol. 30:* 195-196.

Butler, C. G., Finney, D. J. and Schiele, P. 1943. Experiments on the poisoning of honey bees by insecticidal and fungicidal sprays used in orchards. *Ann. Appl. Biol. 30:* 143-150. *R.A.E.(A) 32:* 36.

Carter, G. A. 1943. Orchard spray poisoning of the honey bee. *Ann. Appl. Biol. 30:* 195.

Cherian, M. C. and Mahadevan, U. 1946. Preliminary trials with DDT and gammexane against the Indian bee *Apis indica. Indian Bee J. 8:* 128-130.

Cook, F. C. and McIndoo, N. E. 1923. Chemical, physical and insecticidal properties of arsenicals. *U.S.D.A. Bull. 1147,* pp. 57. *R.A.E.(A) 11:* 551.

Dethier, V. G. 1947. Chemical Insect Attractants and Repellents. *The Blakiston Co.,* Toronto.

Doane, R. W. 1923. Bees vs. spraying. *J. Econ. Ent. 16:* 527-531. *R.A.E.(A) 12:* 82.

Dobroscky, I. D. 1935. Preliminary report on the fluorine compounds as insecticides. *J. Econ. Ent. 28:* 627-637. *R.A.E.(A) 23:* 530.

Eckert, J. E. 1945. The effect of DDT on honey bees. *J. Econ. Ent. 38:* 369-374.

Eckert, J. E. 1946. Effect of certain insecticides on beekeeping. *Univ. Calif. Agr. Exp. Sta. No. 365:* 22-6.

Eckert, J. E. 1948. Toxicity of some of the newer chemicals to the honey bee. *J. Econ. Ent. 41:* 487-491.

Eckert, J. E. 1948. The relations of agricultural chemicals to bee keeping. *Rept. State Apiarist Iowa 1948,* p. 64.

Evans, H. H. 1942. Bee repellent sprays. *Report of Dept. Agric. Brit. Columbia No. 37,* p. X35.

Evans, H. H. 1943. Bee repellent sprays. *Report of Dept. Agric. Brit. Columbia No. 38,* p. R44.

Evans, H. H. 1944. Bee repellent sprays. *Report of Dept. Agric. Brit. Columbia No. 39,* p. 47.

Eide, B. M. 1947. Insecticides and honey bees. *J. Econ. Ent. 40:* 49-54.

[1] A part of the programme of the Legume Research Committee in Ontario.

Filmer, R. S. and Smith, C. L. 1944. DDT as a contact poison for honey bees. *J. Econ. Ent. 37:* 537.

Filmer, R. S. 1937. Poisoning honey bees by rotenone Derris dusts. *J. Econ. Ent. 30:* 75-77. *R.A.E.(A) 25:* 423.

Finney, D. J. 1947. Probit analysis: a statistical treatment of the sigmoid response curve. *Camb. Univ. Press,* pp. 199-208.

Gerrard, W. J. 1935. Bees and derris dust. *Bee World 16(11):* 121. *R.A.E.(A) 24:* 17.

Goble, G. J. and Patton, R. I. 1946. The mode of toxic action of dinitro compounds on the honey bee. *J. Econ. Ent. 39:* 177-180. *R.A.E.(A) 35:* 251.

Guilhoun, J. 1946. Sensibilité des abeilles aux insecticides synthetiques. *C. R. Acad. Agric. Fr. 32*(7): 246-9. *R.A.E.(A) 36:* 237.

Häfliger, E. 1949. Comparative toxicity of various insecticides to the honey bee. *J. Econ. Ent. 42:* 523-528.

Helson, G. A. H. and Greaves, T. 1946. The use of DDT as an agricultural insecticide. *J. Coun. Sci. Industr. Res., Aust. 18:* 301.

Holland, E. B. 1916. Detection of arsenic in bees. *J. Econ. Ent. 9:* 364-366. *R.A.E.(A) 4:* 389.

Holst, E. C. 1944. DDT as a stomach and contact poison for honey bees. *J. Econ. Ent. 37:* 159. *R.A.E.(A) 32:* 387.

Hoskins, W. M. and Harrison, A. S. 1934. The buffering power of the contents of the ventriculus of the honey bee and its effect upon the toxicity of arsenic. *J. Econ. Ent. 28:* 924-42.

Knowlton, G. F. 1944. Poisoning of honey bees. *Utah Agr. Expt. Sta. Mimeo-series 310.*

Knowlton, G. F. 1946. DDT and bees. *Utah Agric. Exp. Sta. Mimeo-series 321. R.A.E.(A) 35:* 109.

Knowlton, G. F. 1948. Some relationships of the newer insecticides to honey bees. *Utah Agr. Expt. Sta. Mimeo-series 725.*

Kulash, W. M. 1945. DDT and control of honey bees. *J. Econ. Ent. 38:* 609-610.

Linsley, E. G. 1946. Insect pollinators of alfalfa in California. *J. Econ. Ent. 39*(1): 18-29.

Linsley, G. G. and MacSwain, J. W. 1947. The effects of DDT and certain other insecticides on alfalfa pollinators. *J. Econ. Ent. 40:* 358-63.

McGregor, S. E., Caster, A. G. and Frost, M. H., Jr. 1947. Honey bee losses as related to crop dusting with arsenicals. *Arizona Expt. Sta. Tech. Bull. No. 114.*

McGregor, S. E. and Vorhies, C. T. 1947. Beekeeping near cotton fields dusted with DDT. *Arizona Agr. Expt. Sta. Bull. 207.*

McIndoo, N. E. 1917. Effects of nicotine as an insecticide. *J. Agric. Res. 7:* 89-122. *R.A.E.(A) 5:* 21.

McIndoo, N. E. and Demuth, G. S. 1926. Effects on honey bees of spraying fruit trees with arsenicals. *U.S.D.A. Bull. 1364,* 32 pp. *R.A.E.(A) 14:* 408.

Nelson, F. C. 1937. The use of honey bees for testing liquid insecticides. *J.N.Y. Ent. Soc. 45:* 341-352. *R.A.E.(A) 26:* 109.

Parker, R. L. 1925. Marking bees for behavior studies. *J. Econ. Ent. 18:* 587-590.

Prell, H. 1934. Ueber die Dosis letalis minima des Arsens für Bienen. *Anz. Schädlingsk 10:* 30-31. *R.A.E.(A) 22:* 267.

Roark, R. C. and McIndoo, N. E. 1944. A digest of the literature on DDT through April 30, 1944. *U.S.D.A. Bur. Entom. Plt. Quar. E-631.*

Roark, R. C. and McIndoo, N. E. 1946. A second digest of the literature on DDT (May 1, 1944-Dec. 31, 1944). *U.S.D.A. Bur. Entom. Plt. Quar. E-687.*

Roark, R. C. and McIndoo, N. E. 1947. A third digest of the literature on DDT. *U.S.D.A. Bur. Entom. and Plt. Quar. E-728.*

Schneider-Orelli, O. 1945. Pest control and flowers visited by bees. *Schweiz. Bienenztg. Beih. 9:* 423-429. *R.A.E.(A) 35:* 380.

Schulz, H. 1947. Contributions to the susceptibility of honey bees to arsenic with special consideration to the threshold of toxicity. *Z. Angew. Ent. 27: 655-666. R.A.E.(A) 35:* 74.

Schimke, H. 1935. Ueber die giftigkeit einiger arsenfreir Bekämpfungsmittel fur die Bienen. *Verh. dtsch. Ges. Angew. Ent. 9:* 103-111. *R.A.E.(A) 23:* 299.

Scullen, H. A. 1948. Protecting pollinating insects from insecticides. *Agric. Exp. Sta. Oregon St. Coll. St. Circ. Inf. No. 431.*

Shaw, R. F. 1941. Bee poisoning—a review of the more important literature. *J. Econ. Ent. 34:* 16-21. (N.B. This review contains some relevant references not given in this bibliography).

Shaw, F. R. and Bourne, A. I. 1944. Observations on bee repellents. *J. Econ. Ent. 37:* 519-521. *R.A.E.(A) 33:* 212.

Smith, R. F., MacSwain, Linsley, G. G. and Platt, F. R. 1948. The effect of DDT dusting on honey bees. *J. Econ. Ent. 41:* 960-971.
Sordinas, J. 1924. La lutte contre la mouche de l'olive a Corfu. *Redia 15:* 97-103. *R.A.E. 12:* 190.
Sprenger, A. M. 1918. De Bestrijding von Insecten met Arsencumpraeparaten en het Gevaar vor de Bezenteelt. *Tijdschr. Plantenziekten, Wageningen. 24:* 21-25.
Svoboda, J. and Peterka. 1938. Ferric hydrate as a treatment for arsenic poisoning in bees. *Vcela mor. Brno. reported in Bee World 19:* 21. *R.A.E.(A) 26:* 255.
Symposium (1939) Bienen-und Seidenzucht. *Verh. 7 int. Kongr. Ent., Berlin 1938.* Pp. 1735-1904. Weimer 1939. *R.A.E.(A) 33:* 6.
Tietz, H. M. 1924. The solubility of lead arsenate in the digestive fluids of the honey bee. *J. Econ. Ent. 17:* 471-477.
Turnbull, W. H. 1947. History of the use of bee repellents in orchard sprays in the Okanagan Valley of B.C. *Proc. Ent. Soc. B.C. 42:* 7-8. *R.A.E.(A) 35:* 60.
Way, M. J. and Synge, A. D. 1948. Effects of DDT and of benzene hexachloride on bees. *Ann. Appl. Biol. 35:* 94-109.
Wiesmann, R. 1942. Uber neue wirksame Arsenersatstoffe in Obstba und ihre Bedeutung fur die Bienenzucht. *Schweiz Bienen Ztg. 65(5):* 227-229.
Wilson, M. 1946. DDT as a stomach poison for honey bees. *Bios. 17:* 157.
Woodrow, A. W. 1948. Tests with DDT on honey bees in small cages. *U.S.D.A. Admin. Bur. Ent. Plt. Quar. E763.*
Wolfenbarger, D. O. 1944. DDT for "out of place" honey bee colonies. *J. Econ. Ent. 37:* 849-850.

Book Review

***The Biological Control of Prickly Pears in South Africa.* By F. W. Pettey. Union of South Africa, Department of Agriculture, Sci. Bull. 271. (Entomology Series No. 22). 163 pp., 31 figs., 3 col. pls., 1 map, 33 refs. Pretoria: The Government Printer, 1948. (Price 1/-).**

Approximately 20 species of *Opuntia* occur in South Africa. All were originally introduced from the Americas about the middle of the 18th century either as ornamental plants, as hedges, or for the sake of their fruits. All later became weeds of the veld. By 1890, the infestation of land by the two main species (*O. megacantha* and *O. aurantiaca*) was so extensive that they were made the subject of legislation by the Cape Parliament. Chemical eradication was attempted and carried on for some years but it became too costly for both the farmer and the State. In 1932 it was finally decided to attempt the control of pest pears by biological methods following the Australian experience. In that year, the moth *Cactoblastis cactorum* was introduced and, in 1938, areas of pear were reserved for its wide establishment in the field since it had given promising results in the preliminary years.

The present bulletin is an account of the campaign against the common pest pear (*O. megacantha*) and the jointed cactus (*O. aurantiaca*). The history opens with an account of the introduction and establishment of *Cactoblastis* and of its only partial success in combatting the pear. A number of factors combined to restrict its activity, among which are the more resistant nature of the species of pear concerned and several physical and biotic factors in the new environment. In the final result, it was found unable, by itself, to destroy well-established pear plants. It does, however, prevent the spread of the pest pear by its attack on and destruction of very young, isolated plants in the veld.

Among the four other insects imported to supplement the work of *Cactoblastis*, striking success was obtained with only one, *Dactylopius opuntiae*, which was introduced in 1937. This cochineal insect at first gave promise of completely exterminating the pear of both pest species in a very short time. Unfortunately, however, it was soon attacked by an indigenous Coccinellid, *Exochomus*

flavipes Thnb., which found an ideal host concentration on the pear. This beetle was joined by the previously imported *Cryptolaemus montrouzieri* Muls. which was present in the citrus orchards of the Cape. These two predators, between them, are able to reduce the population of *Dactylopius* to a level which is well below that required for the destruction of the pear. The position is such that, while the cochineal will kill off a large proportion of the plant, regrowth is not entirely prevented unless other measures are taken at the critical time. These consist of chopping out the pear when it is well-infested with the cochineal. When this is done, there is no regrowth and the plants are eliminated.

Dactylopius is not as successful on the jointed cactus and this pear presents a more difficult problem. In the opinion of the author of the bulletin future prospects for the biological control of *O. aurantiaca* are not bright. It will be necessary to use mechanical and chemical methods to supplement biological control if it is to be effectively dealt with under South African conditions.

The bulletin makes interesting reading but leaves one with the impression that a great opportunity of studying the more intimate relationships between insects and their environment has been lost through the haste which was without doubt dictated by the economic interests involved. It is true that a number of more intensive investigations were made during the course of the general programme of work, but these were all restricted to the needs of the immediate practical problem in hand and touch only the fringe of any broader population study. Perhaps one day it will be realized by the powers that be that such opportunities occur so rarely that we cannot afford to miss any of them if we are to learn the lessons which are of real value to mankind.

The paper is well illustrated by well-chosen photographs and by three excellent coloured plates. It is a matter for regret that the reproduction of the general text figures is poor. The set-up and printing also leaves much to be desired. A paper of the general interest and importance of the present one seems to warrant better production than has been meted out in this case.

On the whole, however, the bulletin is a valuable documentary account of a strenuous campaign against a serious menace to agricultural areas and the author is to be congratulated on the general outcome of his efforts and those of his staff even though these are not as completely successful as he may have hoped.

G. C. Ullyett.

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